SYMBOL DESIGNING OF BOUNDARY LINES IN 3D GIS BASED ON CHARACTERISTICS

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ABSTRACT
Boundary lines as one of seven basic elements of map play an important role in the usage of 2D map or GIS. By thousands of years practice, cartographer has created a series of symbols to reflect boundary lines on map, and those symbols have been accepted by map users though they do not know why boundary lines have been drown like that. Boundary lines have special characteristics that are difference with other elements. This paper is focused on the symbol designed of boundary lines based on their special characteristics. Three kinds of boundary lines symbols are designed for 3D GIS: Spatial virtual reality symbols, Reality symbols and 2.5D surface symbols. 3D GIS with its advanced function, dynamic, multidimensional, multiscale, will be used widely in urban planning, natural resource management, telecommunication and so on. Designing and showing boundary lines symbols in 3D GIS is a valuable topic in the research of development of GIS.

INTRODUCTION

Traditional maps using map symbols to display the real world in 2D have been used thousands of years. Boundary lines as one of seven basic elements in 2D map give the effective function to map users to understand the real world though they do not know why boundary lines have been drown like that. In the ancient times, the natural object, a river, a mountain, was used to be a national boundary lines to separate the two countries. The boundary lines only limited the function of breaking down the land to two sides. The position and accuracy of boundary lines are vague. The usage of boundary lines using was determined at narrow range from sorts to spatial scopes. Nowadays, the definition of boundary lines accepts more and more new components. For instance, it spatial range expands to the sky and to the underground from ground surface, and the positions can exist anywhere not defined a natural object that is clear to identify.

There are three kinds of boundary lines statistically in the field, natural object such as a river, a road that is used to be a boundary lines; the second is the man-made such as boundary marks, landmarks; the third is no natural object, no boundary marks but only position coordinates. Figure 1 give the example to show some symbols of boundary lines to be used in 2D map. As we see in the example, boundary lines are enunciated by depicted as a series of lines: straight or curve line. including dash lines, dot lines and so on, associated with colors and the width of line.

Figure 1. Example of 2D boundary lines

Map as a referenced tool is used to display the dynamic and multidimensional reality in static and 2D. With the development of GIS, the shortcoming of map has been solved partly in 2D GIS. As we will see next, boundary lines have own specific characteristic. In 2D map or GIS, those natural characteristics can not be described. Those shortcomings restrict the usage of map or GIS.

3D GIS(some researchers use 4D or 5D) with its advanced function: visual including augmented reality and virtual reality; dynamic including spatio-temporal process modeling, dynamic objects, dynamic process; multidimensional and multiscale, will be used widely in urban planning, natural resource management, telecommunication and so on. The development of 3D

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GIS let it possible to design and show the natural characteristics of boundary lines at the virtual reality, dynamic and multidimensional environment.

METHODOLOGIES

Boundary lines have own special characteristics with others elements:

- **Limiting**

The basic meanings of boundary lines are the limitation of going in or out selectively. The function can not be showed in the paper map, but we can do that in 3D GIS.

- **Linear**

In most of the case, we can say that the boundary lines are linear symbol with existing width or without existing width. It is different with the imaginary lines like contour lines.

- **Spatial**

National boundary lines have the space characteristics not only on the ground but also in the sky and underground even there are not any marks built in the sky or underground. At the same time, the space extend are limited according to the type of boundary lines.

- **Continuous and Close**

Any boundary line must be continuous and close though sometimes we do not depict them on the map.

- **Political**

Boundary lines especially the national boundary lines show the standpoint of the map/GIS makers.

- **Non-object**

Boundary lines exist with or without you build marks on the ground, and they do not limit in how high or how wide of the mark you built, too.

- **Strict**

It is unallowable to generate the boundary lines using generalization theories such as refinement.

- **Lawful**

Boundary lines are determined by law but not natural exist. Boundary lines are the only element that has the lawful function among elements.

Those characteristics of boundary lines are nor suitable to all the boundary lines one by one and they decide that we must consider those characteristics when we design boundary lines symbols.

Three main kinds of symbols of boundary lines are designed in this paper based on the characteristics of boundary lines.

1. Spatial virtual reality symbols

The kinds symbols are designed for those that have spatial and limiting characteristics including national boundary lines and some state boundary lines. They have some characteristics:

- Spatial extend(non-infinite)
- Perspective
- Through under permit

Four symbols are designed as below (Figure 2)

a. web
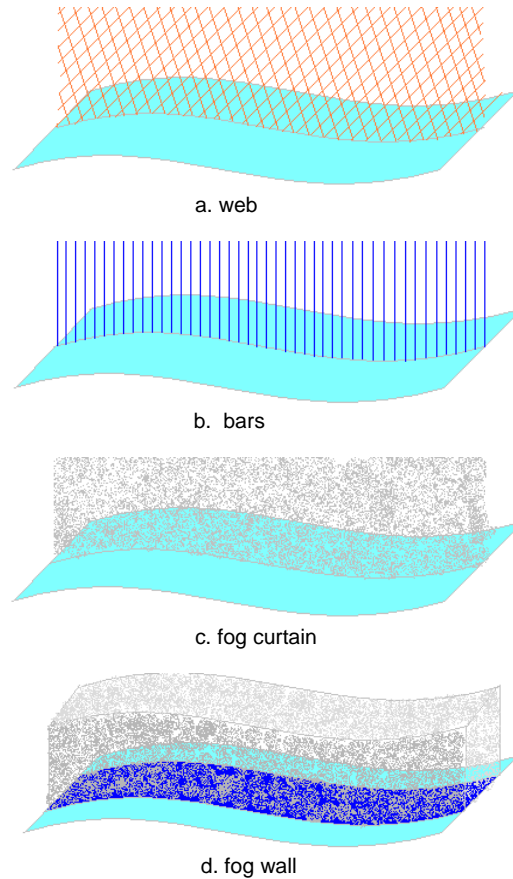

b. bars

c. fog curtain


d. fog wall

Figure 2 Spatial virtual reality symbols

Figure2 (a-c) are used to show those boundary lines that have no real wide or have certain wide but can not show its width under this scale. Figure 2(d) is used to those boundary lines that can show the width of boundary lines

2. Reality symbol

There are a lot of kinds of symbols according to the real boundary marks. The kinds of symbols have below characteristics:

- Existing marks
- Limiting spatial extend
- Through under permit

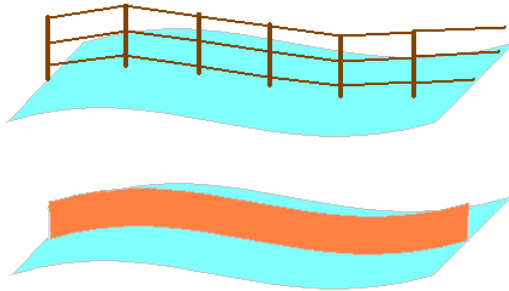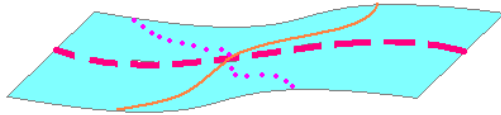Some examples for the kinds of symbols are gave in figure 3
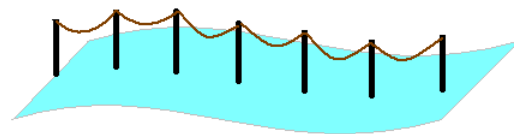
Figure 3. Reality symbols

3. 2.5D surface symbols

Almost all 2D boundary lines symbols that have been used on map can be extended to 3D GIS.

CONCLUSION

Thoughtful consideration of which is to be used in your GIS, and what is not, can save you a lot of trouble in the later stages of your work. In this paper, some elementary symbols (not all) have been designed. The proposal of the author is to give the basic designing ideas about boundary lines in 3D GIS. Those symbols are not certainly, the author believes, suitable for the GIS using. The author also has not experience to use those symbols in 3D GIS projects.

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